REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	15 MAY 1998	FINAL REPORT (07-97 TO 05-98)

4. TITLE AND SUBTITLE
IMPROVING ACCESS TO DENTAL HYGIENE SERVICES IN THE EUROPEAN REGIONAL DENTAL COMMAND CONCURRENT WITH IMPLEMENTATION OF THE U.S. ARMY DENTAL CARE REENGINEERING INITIATIVE

5. FUNDING NUMBERS

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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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CMR 402
APO AE 09180

8. PERFORMING ORGANIZATION REPORT NUMBER
28-98

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
US ARMY MEDICAL DEPARTMENT CENTER AND SCHOOL
BLDG 2841 MCCS-HRA US ARMY-BAYLOR PROGRAM IN HCA
3151 SCOTT RD SUITE 1412
FORT SAM HOUSTON, TEXAS 78234-6135

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

THE ARMY DENTAL CARE SYSTEM HAS HISTORICALLY PROVIDED QUALITY DENTAL CARE TO AMERICA'S ARMY AND REMAINS COMMITTED TO BEING A WORLD CLASS DENTAL CARE SYSTEM. IN RESPONSE TO RECENT DECREMENTS IN PERSONNEL AND FINANCIAL ASSETS, THE ARMY DENTAL CORPS IS TESTING THE DENTAL CARE REENGINEERING INITIATIVE (DCRI)--A CONCERTED EFFORT TO MAXIMIZE CLINICAL EFFICIENCIES AND FACILITATE BETTER BUSINESS PRACTICES THROUGH OPERATIONAL PERFORMANCE IMPROVEMENT. ONE OF THE UNRESOLVED PROBLEMS WITH IMPLEMENTATION OF THE DCRI IN EUROPE IS THE SHORTAGE OF DENTAL HYGIENISTS IN THE EUROPEAN THEATER. THIS STUDY WAS DESIGNED TO ADDRESS THE HYGIENIST SHORTAGE BY USING COMPUTER SIMULATION TO INVESTIGATE TWO PROPOSED STAFFING MODELS DESIGNED TO INCREASE THE EFFICIENCY OF DENTAL HYGIENISTS. THE FIRST WAS THE EUROPE PRIMARY CARE-DCRI STAFFING MODEL WHICH CONSISTED OF TWO DENTAL HYGIENISTS WORKING OUT OF TWO CHAIRS WITH THE BENEFIT OF A SHARED HYGIENE ASSISTANT. THE SECOND WAS THE EXPANDED HYGIENE MODEL WHICH CONSISTED OF ONE HYGIENIST WORKING OUT OF TWO CHAIRS WITH A HYGIENE ASSISTANT. THE EUROPE PRIMARY CARE-DCRI MODEL DID NOT INCREASE THE NUMBER OF PATIENTS THAT COULD BE TREATED BY THE TWO HYGIENISTS WORKING WITHOUT AN ASSISTANT. THE EXPANDED HYGIENE MODEL ALLOWS ONE HYGIENIST TO INCREASE PATIENT THROUGHPUT WITH THE POTENTIAL TO MEET THE HYGIENE REQUIREMENTS OF PATIENTS IMPANELED TO TWO PRIMARY CARE TEAMS. IT INCREASES ACCESS TO ELIGIBLE BENEFICIARIES AND SHOULD BE CONSIDERED AS THE PREFERRED HYGIENE STAFFING MODEL FOR THE EUROPEAN REGIONAL DENTAL COMMAND.

14. SUBJECT TERMS	15. NUMBER OF PAGES
DENTAL CARE REENGINEERING INITIATIVE, DENTAL STAFFING MODELS, COMPUTER SIMULATION IN DENTISTRY	74
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
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Running Head: IMPROVING ACCESS TO DENTAL HYGIENE SERVICES

Improving Access to Dental Hygiene Services in the European Regional Dental Command Concurrent With Implementation of the U.S. Army Dental Care Reengineering Initiative

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Abstract

The Army Dental Care System has historically provided quality dental care to America's Army and remains committed to being a world class dental care system. In response to recent decrements in personnel and financial assets, the Army Dental Corps is testing the Dental Care Reengineering Initiative (DCRI)--a corporate effort to maximize clinical efficiencies and facilitate better business practices through operational performance improvement. Key tenants of the DCRI are the endorsement of managed care principles and the use of dental care delivery models that allow primary care teams to use multiple dental treatment chairs and multiple dental ancillaries. The DCRI is currently being tested at five Army dental clinics in the continental U.S. The Vilsek Dental Clinic in Germany has been identifed as the "beta" test site for the DCRI in Europe with implementation scheduled to occur during the spring of 1998.

One of the unresolved problems dealing with implementation of the DCRI in Europe is the shortage of dental hygienists in the European theater. This study was designed to address the dental hygienist shortage by using computer simulation to compare two different staffing models designed to increase the efficiency of dental hygienists. The first was the Europe primary care-DCRI staffing model that consists of two dental hygienists working out of two chairs with the benefit of a shared hygiene assistant. The second was the expanded hygiene model that consists of one hygienist working out of two chairs with a dedicated hygiene assistant. The Europe primary care-DCRI model did not increase the number of patients that could be treated by the two hygienists working without an assistant. The expanded hygiene model allows one hygienist to increase patient throughput with the potential to meet the hygiene requirements of patients impaneled to two primary care teams. It increases access for eligible beneficiaries and should be considered as the preferred hygiene staffing model for the European Regional Dental Command.

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INTRODUCTION

Conditions which prompted the study

The Army Dental Care System (ADCS) has historically provided quality dental care to America's Army and remains committed to being a world class dental care system. In a chaotic time of shrinking financial and personnel assets, the challenge of the ADCS is to continue to improve the dental readiness of today's Army. This is evidenced by the goal to achieve oral health wellness for 95% of the active duty population by ensuring they are Dental Class 1 and 2 (Cuddy, 1997).

The senior Dental Corps leadership has addressed this expectation as part of the strategic planning process and examined the strengths, weaknesses, opportunities, and threats pertinent to the ADCS. Their findings indicate that the practice patterns of the ADCS remain inefficient and inconsistent at a time when civilian dental delivery systems are progressing to accommodate change both at the clinical and administrative level. This weakness is alarming especially since military patient care outcomes are benchmarked against some of the best dental managed care organizations in the country. Additionally, there is increasing concern that the downsizing of the force, pay incomparability, and lack of accessions have hurt the morale of the dental workforce. The combination of all these factors fuels the perception that outsourcing dental care in the ADCS is entirely feasible and justifiable (Lambert, Nasser, & Wineman, 1997).

MG John J. Cuddy, Chief of the U.S. Army Dental Corps, requested a staff study to examine methods that maximize clinical efficiencies and facilitate better business practices through operational performance improvement. This Army team consisted of seven specialty-trained comprehensive dentists, a public health dentist, a prosthodontist, and a Medical Service Corps

health care administration officer with managed care expertise. The team studied pertinent literature, discussed managed care principles and their relationship to dentistry, visited quality dental managed care organizations and fee-for-service dental practices, and employed dental consultants. The end result of the team's effort was the development of a model with associated metrics and standards that allows each command element in the ADCS to achieve model compliance and improve the quality of practice for the ADCS's workforce. The final report is the Concept and Feasibility Plan for the Implementation of a Team Dental Health Care Delivery Model for the Army Dental Care System dated 6 February 1997.

In the final report, the team offered the following recommendations for improving the ADCS's business practices and patient care efficiencies:

1. Impanel all soldiers to a general dentist primary care manager (PCM).

2. Institute managed care principles inclusive of population profiling, dental treatment facility profiling, dental delivery management, disease management, and outcome measures.

3. Require a universal one-year advanced educational general dentistry program for all incoming dental officers.

4. Increase personal services contracts (PSCs) for dental providers. This initiative allows replacing centralized contracts for dentists with decentralized PSCs at the discretion of the local dental commander. The result is a customized staff of dentists, hygienists, and assistants whose mix is tailored to the organization.

5. Use a dental delivery model that employs automation, multiple chairs, and multiple ancillaries.

6. Provide formal training to dentists and ancillaries in the principles of team dentistry (Fretwell et al., 1997).

The Expanded Board of Directors in the ADCS unanimously approved the Concept and Feasibility Plan for the Implementation of a Team Dental Health Care Delivery Model for the Army Dental Care System in February 1997 and agreed that five U.S. Army dental clinics would serve as "beta" test sites for the plan in the continental U.S. (CONUS). The Surgeon General of the Army approved the plan in March 1997 and the Assistant Secretary of Defense for Health Affairs concurred in April. Additionally in April, a formal title was given to the project—the Dental Care Reengineering Initiative (DCRI) (Lambert et al., 1997).

The DCRI consists of two functional elements, the Oversight Committee and the Implementation Team. Working with the leadership of the five "beta" sites and the U.S. Army Dental Command (DENCOM), the Oversight Committee and the Implementation Team are simultaneously determining resource requirements and refining the plan. Current plans indicate that after "beta" site testing, the DCRI will be seeded to other clinics and installations and eventually become the standard operating procedure throughout the ADCS in two to three years. The DCRI is designed to be cost neutral—there will initially be no cost savings or avoidance and expenses for the program are not programmed to exceed existing budget levels (Lambert et al., 1997).

The main objective of the DCRI is to improve business practices and clinical efficiencies in the ADCS by maximizing the provider's treatment time, removing the unnecessary administrative burden from the clinical staff, improving access for patients, and creating a quality practice. The goals are to:

1. Surpass the 95% benchmark for dental readiness as measured by the number of active duty personnel categorized as Dental Class 1 and 2.

2. Establish a benchmark for the oral health wellness as measured by the percentage of

Dental Class 1s in the population.

3. Be the provider of choice for the population served as measured by satisfaction surveys.

4. Improve the work environment by expanding the quality and scope of practice for the dental work force as measured by worker satisfaction surveys.

5. Demonstrate long-term cost effectiveness by reducing dependency on contract dental support, eliminating excess capacity, and meeting stated goals at budget rates equal to, or below, the DENCOM average (Lambert, et al., 1997).

Dental teams organized under the DCRI guidelines in CONUS will consist of one dentist, two full-time dental assistants [one may be an expanded duty dental assistant, known in the military as a dental therapy assistant (DTA)], one hygienist, a shared roving assistant, a shared treatment coordinator, and a shared sterilization assistant. In the ideal configuration, two teams will occupy a dental treatment bay and each team will be assigned either three to four dental chairs. The team will be accountable for fulfilling and managing the dental care needs of their respective panel of service members including the readiness component. The panel sizes will vary with a typical range of 1200-1500 patients (Cuddy, 1997).

Dental patients impaneled to teams are members of a preventive based practice with risk assessment protocols, practice guidelines, and critical pathways for high cost and high volume procedures. The following critical pathway has been adopted to insure continuity of care and improve access:

1. Preliminary exam/diagnosis
2. Treatment of urgent conditions (Dental Class 3 problems)
3. Dental hygiene phase that emphasizes preventive treatment.

4. Non-elective treatment that includes restorative, oral surgery, periodontal and endodontic procedures.

5. Elective treatment that includes prosthetic, periodontal, and esthetic therapy.

Dental maintenance provides a continuum in the therapy and includes an active recall system conducted by hygienists and/or care finders with the recall appointment intervals tailored to the caries and periodontal disease assessment of the patient. The use of this critical pathway will allow the ADCS to better use of resources, maximize the quality of care, and reduce inefficiencies by reducing provider variation (Fretwell et al., 1997).

The implementation of the DCRI in the European Regional Dental Command (ERDC) is scheduled for the spring of 1998. The "beta" test site in the ERDC has been identified as the Vilsek Dental Clinic, a recently constructed 18 chair dental facility. There are two open bays, and each bay contains eight chairs. Additionally, there are two treatment rooms, each containing a dental chair, that are not affixed to the standard open bay layout.

The implementation of DCRI into the ERDC poses unique problems not encountered by the "beta" test sites in CONUS. In the ERDC, active duty personnel and their family members are eligible beneficiaries of the ADCS and both will be impaneled with a primary care manager.

After considering the present beneficiary population plus the available manpower and budgetary constraints, the ERDC Commander determined that 107 primary care panels are required in Europe. Each panel will have a dentist to population ratio of 1:1400 rather than the 1:1200 ratio currently employed at the "beta" test sites in CONUS. This will require an additional eight primary care dentists and 26 dental hygienists to meet the Europe primary care staffing-DCRI model ratio. One long-term assumption of the Europe primary care staffing-DCRI model is that many family members will enroll in a comprehensive dental care insurance plan tailored for

beneficiaries outside CONUS once it becomes available. As a result, the family member requirements should become less resource intensive as their needs shift from comprehensive care on demand to maintenance care. (L. D. Fretwell, personnel communication, December 1, 1997).

The DCRI guidelines indicate that either three or four dental chairs will be allocated to the primary care dental teams. There are, however, an inadequate number of dental chairs to support both the Europe primary care staffing-DCRI model and the dental specialists in the ERDC if the four-chair model is used exclusively for the 107 primary care teams. There are currently 35 dental clinics in the European ADCS with a combined total of 430 dental chairs. Current projections indicate that the Europe specialty staffing-DCRI model will require 93 dental chairs resulting in a gross difference of 337 chairs for the primary care providers. If the 107 primary care teams are allocated four chairs, there is a 91-chair deficit. To compensate for this delta, the ERDC Commander has proposed that the primary care staffing model for Europe consist of a team that operates out of a three chair dental model. This dental chair allocation should impanel the entire active duty and family member population in Europe with a total of 321 dental chairs. The 16 dental chair surplus could be used to allow dentists and dental hygienists assigned to field units the opportunity to practice in the dental clinics or serve as a backup for other chairs requiring maintenance (L.D. Fretwell, personal communications, December 1, 1997).

The ERDC Commander has proposed that the European primary care-DCRI team model will consist of one dentist, one dental hygienist, and the equivalent of three dental assistants. The dental assistant mix will consist of two chairside assistants who are assigned to a specific dental chair and two assistants shared equally with another team. The shared personnel will be a hygiene assistant and an assistant with sterilization and patient coordinator responsibilities (L.D. Fretwell, personal communications, December 1, 1997).

Currently in the ERDC, most primary care dentists and hygienists work primarily out of one chair and treat one patient each hour. This scheduling template has become part of the organizational culture. The reasons for the one chair/one hour/one patient model are numerous and include additional time requirements to clean-up and prepare the operatory given stringent infection control procedures, provider unwillingness to expand their practice into multiple dental chairs due to inadequate ancillary support, and reluctance of assistants to utilize a second dental chair which translates into additional cleaning and maintenance requirements for them (Connor & Nasser, 1997). The proposed Europe primary care staffing-DCRI model is a paradigm shift promoting improvement of clinical efficiencies and better business practices, but it will require additional dental hygienists and dental ancillary personnel.

The additional requirement for 26 dental hygienists is especially problematic. The military community's demand for dental hygiene appointments currently exceeds the supply in Europe. There simply are not enough dental hygienists to provide care.

Individuals who function as dental hygienists in the ERDC can be either general schedule civilians, contract civilians, or military preventive dentistry specialists. Dental hygienists hired as general schedule employees are paid significantly less than what they could earn in private practice or as contract hygienists for the military. As a consequence, many civilian positions remain unfilled. Contract dental hygienists hired by the dental contractor are well paid, but there are only a few in the inventory in Europe and it is unlikely that additional ones will be hired given the current and projected budgetary constraints. Military preventive dentistry specialists have completed a program in basic dental hygiene, a specialty that has been designated a critical wartime skill. Military preventive dentistry specialists assigned to Europe are usually placed in Table of Organization and Equipment (TOE) units that are the first priority of fill (D. Anfield, personal

communication, March 12, 1998). Preventive dentistry specialists assigned to TOE units only practice when their field unit requirements are met (P. Hamilton, personal communications, November 13, 1997). A U.S. Army Audit Agency Study (1996) found that most preventive dentistry specialists were getting little practice in their military occupational specialty and were spending most of their time on non-dental duties such as motor pool or lawn maintenance details. The Audit Agency's recommendation was that the DENCOM request approval from the Department of the Army to have the preventive dentistry specialists assigned to TOE units reassigned to Table of Distribution and Allowances dental clinics. The preventive dentistry specialists would then be placed in the enlisted Professional Filler Program to meet the needs of the TOE units.

The American Dental Association has long endorsed regular dental hygiene services as a cornerstone to oral health. This endorsement has been bolstered by recent articles in the professional literature which implicate periodontal disease as a major risk factor in cardiovascular disease, stroke, and production of low-birth weight babies (Loesche, et al., 1998; Offenbacher, Katz, & Fertig, 1996).

The requirement for 26 additional hygienists poses a significant problem in addressing the hygiene needs of the beneficiary population, and it is reasonable to assume that the ERDC may experience additional demands for dental hygiene services once the link between oral and systemic health is publicized in the military community. It also has the potential to block successful implementation of the key tenants of DCRI in Europe—meeting hygiene access standards, supporting oral health wellness and prevention programs, and revitalizing dental health promotion in the ADCS.

Statement of the Management Problem

Given the paucity of dental hygienists currently assigned to the ERDC and the projected need for 26 additional hygienists to implement the DCRI, the ERDC Commander has requested management studies to evaluate the effectiveness (a) of the current proposed dental hygiene staffing configuration in the Europe primary care staffing-DCRI model and (b) an alternative hygiene staffing configuration that is compatible with the Europe primary care -DCRI model and demonstrates clinical efficiencies and sound business practices.

Literature Review

The current ADCS's model for dental hygiene services is a dental hygienist working out of one chair without an assistant with one patient scheduled every hour for most appointments. It has not changed significantly since the mid-1970s when Cooper (1974) introduced process management techniques for dental practices—the only exceptions being the introduction of ultrasonic scalers and directives mandated by the Occupational Safety and Health Act (OSHA). Cooper endorsed (a) preplanning of appointments as an adjunct to time management, (b) simplification of instrumentation by retaining only instruments necessary to complete procedures consistent with high quality dentistry, (c) standardization of operating procedures by the arrangement and usage of dental instruments in a predetermined sequence, (d) use of pre-prepared dental trays to promote an efficient means of instrument delivery, and (e) correct physical positioning of the operator, patient, and assistant in the dental treatment room. All of these techniques were successfully integrated into and still practiced, to varying degrees, in civilian and military dental settings. Current OSHA infection control and sterilization requirements are rightfully mandated given the potential for disease transmission in the dental treatment setting, but these measures are time intensive and performed at the expense of productivity.

Private practitioners who still use this 1970's hygiene model may view their hygiene department as a break-even or even a money-losing venture. Many progressive practitioners, on the other hand, have turned their hygiene departments into profit centers by managing the variance of the appointment lengths and/or reorganizing the department by addition of ancillary personnel and dental chairs.

Schulman (1987) developed a program that individualizes the amount of time required for the hygiene appointment based on an appraisal of each patient by the hygienist or dentist during the dental examination. He believes that the normal defaults of allocating a 45-minute appointment for the adult and the 30-minute appointment for children are inaccurate standards. This customized scheduling results in more patients treated each day, but it also requires that the patient return to the dental office for the hygiene appointment.

Neuman (1992) advocates the creation of a new dental ancillary position, the dental hygiene coordinator, to help manage the increased demand for nonsurgical periodontal and soft tissue modalities in a periodontal practice. The dental hygiene coordinator works independently during the dental hygiene appointment to increase the ability to the hygienist to care for patients. The model consists of a dental hygienist, a dental hygiene coordinator, and two treatment chairs. For scaling and root planing and periodontal maintenance appointments, the coordinator prepares the room, seats the patient, reviews the medical history, takes the blood pressure if necessary, and establishes rapport with the patient. For maintenance appointments only, the dentist performs a periodontal examination and the coordinator records all information. If necessary, the dentist anesthetizes isolated areas as needed for both the maintenance and scaling and root planing appointments. The purposed treatment is reviewed with the hygienist. The hygienist scales, root planes, and polishes the teeth. Once the polishing procedure is complete, the hygienist is free to

treat another patient that was previously seated by the coordinator in the second chair. The coordinator returns to the initial patient, flosses the teeth, educates the patient concerning home care techniques based on directions from the hygienist or dentist, and irrigates subgingival periodontal pockets. The patient is dismissed from the clinical setting and directed to the reception desk. The coordinator places the treatment entry in the patient's chart, cleans the room, prepares for the next patient, and sterilizes instruments. Patients can be treated in 30 minutes increments using this model.

Seltzer (1995) recommends the following management actions to promote hygiene efficiencies and better business practices that ultimately result in increased profitability:

1. Create a hygiene profit center by empowering the hygienist with profit and loss responsibility and base the hygienist's compensation on profitability.

2. Delegate hygiene scheduling control to the hygienist and use computer software to record procedures and schedule appointments.

3. Provide each hygienist with a clinical/administrative assistant.

4. Designate two rooms for each hygienist.

5. Use the hygienist or assistant to educate every patient for three to five minutes using electronic imaging devices such as intraoral video cameras.

To improve the hygienist's efficiency, Seltzer advocates the Seltzer Institute hygiene/ assistant model. In this model, the assistant prepares the room, seats the patient, reviews the medical history, takes the blood pressure if necessary, exposes and develops radiographs, and establishes rapport with the patient. The hygienist enters the treatment room and performs the scaling, coronal polishing, and flossing of the teeth; an intraoral video exam; and oral hygiene instructions. The assistant notifies the dentist who then performs the dental examination. The

assistant enters the chart notes and completes the record, enters pertinent record information into the computer, schedules the next appointment, dismisses the patient, cleans the room, prepares for the next patient, and sterilizes instruments. The hygienist is free to treat another patient that was previously seated by the hygiene assistant in the second chair. According to the time and motion studies done to create the model, the patient spends an average of 45 minutes in the dental treatment chair.

Wilde (1991,1996) advocates an expanded hygiene model that is similar to the Seltzer Institute hygiene/assistant model. The model also involves a dedicated hygiene assistant and two chairs, but the breakdown of tasks between the hygienist and assistant is different. In the first room, the assistant prepares the room, seats the patient, reviews the medical history, takes the blood pressure if necessary, and establishes rapport with the patient. The hygienist then performs the scaling of the teeth and educates the patient concerning oral health wellness and prevention. During this time, the assistant prepares the second room and seats the next patient. The assistant returns to the first room and performs the flossing and polishing of the teeth; topical fluoride is applied if necessary. The assistant also reviews the patient's oral hygiene, demonstrates any dental health aids the hygienist has recommended, and schedules the patient's next recall visit. Sterilization of the instruments and preparation of the dental treatment room finalizes the assistant's duties. This expanded hygiene model allows an increase in the number of patients treated to increase from eight to twelve patients per day.

Jameson (1996) also encourages the use of a dental hygiene assistant and two chairs with a breakdown of tasks similar to both the Seltzer Institute hygiene/assistant model and Wilde's expanded hygiene model. In this model, the assistant prepares the room, seats the patient, reviews the medical history, takes the blood pressure if necessary, exposes and develops radiographs, and

establishes rapport with the patient. The hygienist enters the treatment room and performs a probing and a scaling of the teeth while giving oral hygiene instructions; this is followed by an intraoral video exam. The dentist then does the examination with the assistance of the hygienist. The hygienist is then free to treat another patient that was previously seated by the hygiene assistant in the second chair. The assistant does the coronal polishing and flossing of the teeth, educates the patient concerning any recommended dental health aids, schedules the next appointment, completes the paperwork, and dismisses the patient. Sterilization of the instruments and preparation of the dental treatment room finalizes the assistant's duties. Jameson advocates that patients be scheduled according to their specific needs in ten-minute increments instead of a standard appointment time and recommends an additional responsibility for the dental hygiene assistant—serving as the hygiene retention coordinator. The coordinator's duties are to schedule hygiene appointments, confirm appointments, contact all patients who are past due for a hygiene appointment, and fill voids in the hygiene schedule.

The ability of the a dental hygienist/dental assistant team to work together is predicated on the personalities of the individuals and requires mutual respect and good rapport. Initially, some hygienists are reluctant to delegate selected clinical and administrative tasks fearing they will feel caught up in a "hygiene treadmill." Once an expanded hygiene model is activated, however, the consensus of the literature indicates that hygienists enjoy delegating the mundane tasks of hygiene and are pleased with the additional monetary compensation due to their increased productivity (Jameson, 1996; Miles, 1990; Neuman, 1992; Seltzer, 1995; & Wilde, 1996).

The number of dental personnel to include dental hygienists in the U.S. Army receives periodic scrutiny as the Army continues to "downsize." The U.S. Army Audit Agency (1996) performed an audit study to determine the dental personnel requirements for the Army. One of the

objectives was to determine whether contracts for dental care providers were justified. The audit report recommended that the contracts for dental hygienists are not cost-effective and advocated that the 26 preventive dentistry specialists assigned to TOE units in Europe be reassigned to TDA units to meet the hygiene demands of the military community. The audit team also suggested that the separate examination and hygiene appointments as exist in the current appointment templates be combined into a single visit and any minor restorative dentistry also be consummated during this visit. Their reasoning was to increase access, save on disposable dental materials, and reduce the number of times a soldier would need to visit the dentist. They advised that a dental team should consist of one dentist, one dental assistant, and two hygienists, but no cost-benefit or any time-motion analyses showing this staffing model superior to others was performed.

Until June 1997, the U.S. Army sponsored the Preventive Dentistry Specialty Course to train enlisted personnel to function both as preventive dentistry specialists and DTAs. Dental therapeutic assistants are trained to place restorations in prepared teeth. A U.S. Army Dental Corps survey indicated that graduates were only utilized eight percent of the time as DTAs, and this finding lead to a discontinuation of the expanded duty training component of the course. The course length was reduced and the resources saved were used to fund a pilot program, the Dental Hygienist Course. The U.S. Army and the University of Texas Health Science Center at San Antonio sponsor this intensive course. Students who complete the course have the necessary credentials to challenge State Dental Boards to obtain a dental hygiene license (Asher, 1997). Five to six students start the course annually; four students are scheduled to graduate in 1998. Two will be sent to Europe and assigned to TDA units (D. Anfield, personal communications, March 12, 1998).

Computer simulation is a valuable decision making tool that can be used in management studies conducted on healthcare systems. Not only is it an imitation of an actual process over a length of time, but it is a valuable tool for assessing and comparing proposed process changes in large complex systems that would otherwise require sophisticated numerical methods or be mathematically intractable altogether. It allows the "what if" questions such as "what if the dental hygienist worked out of two chairs with a shared assistant?" The effect of process changes is evaluated through performance measures such as the number of patients seen and the percent utilization of the resources. In addition, unanticipated problems can be exposed before incurring costly and time-consuming investments, especially if simulation results contradict intuition. As an example, the impact of a facility redesign effort can be tested prior to the design being carried beyond the point where changes would be unfeasible or prohibitively expensive (Benneyan, Horowitz, & Terceiro, 1994).

An extensive literature review reveals that no articles have been published concerning the computer simulation of dental services. There is ample literature about other healthcare initiatives that employed computer simulation as a decision-making or management tool.

Computer simulation has been used to determine the optimal staffing ratios in healthcare settings. In a staffing study in a family practice clinic, Allen, Ballash, and Kimball (1997) developed four scenarios involving different staffing ratios of providers and support staff. The intent was to determine the most efficient staffing mix and the number of procedure rooms to allocate to primary care physicians. This study was of interest to an expanding health care organization interested in facility planning in addition to its current and future personnel needs. The simulation results were used to develop a preferred staffing model justifying the appropriate number of patient representatives to work at the front desk given the total patient workload, the

total number of medical assistants needed if they were assigned to a provider either individually or from a pool of available assistants, and the appropriate number of exam rooms per provider. Computer simulation indicated that if more than two examination rooms were available, the patients waited in the examination room instead of the waiting room and the total wait time did not appreciably decrease. This preferred staffing model had a significant cost-savings potential—the number of medical assistants could be reduced if the pool model was instituted and the number of exam rooms allocated per provider could be decreased from three per provider to two.

In an emergency center staffing study by Dawson, Ulgen, O'Connor, and Sanchez (1994), computer simulation was used as a continuous quality improvement tool by a hospital team to evaluate the appropriate nursing and emergency room technician staffing levels for both the current and anticipated future patient volumes. The objective was to maximize the staff utilization to an individual target range of 70-80 percent and reduce patient turnaround times. The team evaluated different scenarios and recommended the additional staffing needed to treat both current and projected patient volumes.

Computer simulation has been used as a continuous quality improvement/total quality improvement tool in addressing issues associated with excessive waiting room delays. Benneyan, Horowitz, and Terceiro (1994) employed computer simulation to analyze patient waiting time in a pediatric department. Computer simulation was chosen since it offered an inexpensive, less disruptive, and a more timely means of evaluation. The simulation modeled proposed changes such as schedule modifications, additional staff, and extra examination rooms. The benefits of this study allowed management to evaluate the fundamental tradeoff between patient waits, resource utilization, and cost containment before instituting permanent changes.

In similar studies, Henderschott (1995) used computer simulation to determine the most appropriate staffing and equipment levels to increase patient throughput in a gastrointestinal clinic. Cirillo and Wise (1996) tested the impact of implementing strategic initiatives at Kaiser Permanente by computer simulating staffing, facilities, scheduling, and process changes. Kalton, Singh, August, Parin, and Othman (1997) used simulation to improve the operation and management of a multi-disciplinary clinic specializing in evaluation and treatment of breast disease.

Computer simulation is a useful tool in business process reengineering. Ditch and Hendershott (1997) examined the business process redesign of an ambulatory admitting service of a hospital. In this study, a "not for profit" hospital had recently been bought by a "for profit" institution and budget pressures became a strong incentive for change. Different scenarios involving staffing, patient flow, work processes, and facility layout were modeled and statistics derived from the simulation were used to support decision-making. In another business process reengineering study by Huebner and Miller (1996), computer simulation was used to restructure a hospital outpatient clinic by reviewing the clinic's facility needs, highlighting any bottlenecks in the current system, and testing the effectiveness of various reengineered process changes before implementation. Several of the process changes required renovation of the facility, and simulation provided justification for the renovation.

A management study to increase access to dental hygiene services concurrent with implementation of the DCRI in Europe lends itself to computer simulation modeling. Computer simulation is a stochastic rather than deterministic method of simulation. A stochastic system incorporates process variability in the simulation process that is a requirement for this study. A deterministic system uses averages for the analysis and can be grossly inaccurate if significant variation exists (Benneyan, 1997).

Purpose

The ERDC Commander has tentatively proposed that the dental hygiene services for two Europe primary care-DCRI teams will consist of two hygienists working out of two chairs with the benefit of a shared assistant. Given the projected shortfall of dental hygienists in the ERDC, it is feasible to examine the management implications of incorporating an expanded hygiene model (one hygienist/one dedicated hygiene assistant/two chairs) to treat the impaneled members of a primary care dental team. The purpose of this study is to (a) measure to the effectiveness of the dental hygiene services both under the proposed Europe primary care-DCRI model and variations of the expanded hygiene model by evaluating the patient throughput and the percent utilization of both the dental hygienists and hygiene assistant on the team and (b) propose an appointment template for the expanded hygiene models.

CHAPTER 2

METHOD AND PROCEDURES

Since the Vilsek clinic was chosen as the "beta" test site for the DCRI in Germany, it was also the clinic used to conduct the study. The scope and complexity of the study necessitated the use of a tool that takes into account the variance in patient processing and treatment times, the travel distances in the clinic, and the ability to make staffing level changes. Computer simulation meets these needs, and MedModel Healthcare Simulation software ™ was selected as the tool to develop and evaluate the model. The purposed patient flow patterns and specific patient care tasks were modeled within one of the two open bays and in the confines of the Vilsek Dental Clinic configuration. This management case study was divided into four phases to obtain the desired results: the initial fact-finding visit, data collection visits, model creation, and model verification and validation.

The initial fact finding visit

The initial visit was designed for familiarization with the number and specialty of the personnel assigned to the clinic, the processes associated with treating dental hygiene patients inclusive of radiology and sterilization services, and the physical plant configuration. Examination of the clinic administrative records to include the patient sign-in rosters, the centralized appointment book, and the dental treatment logs gave insight into what recorded information was available for analysis. Dental treatment logs are registers filled out daily by each provider and yielded information concerning both the numbers of scheduled and unscheduled patients who were treated, the number of scheduled patients who failed to keep their appointments, and the number and types of dental procedures accomplished.

The dental hygiene service at the Vilsek Dental Clinic is responsible for the hygiene needs of approximately 9,250 eligible beneficiaries in the Vilsek Dental Clinic Command footprint. The staff consists of one registered civilian dental hygienist that works out of one chair without a dental assistant. The hygiene service is not staffed adequately to support the needs of the population in its catchment area that has resulted in a demand for services that far outstrip the available supply. The end result is negative marketing of the ADCS in the Vilsek military community.

Implementation of the DCRI at the Vilsek Dental Clinic will require additional personnel, especially in the dental hygiene department. According to the DCRI critical pathway guidelines, impaneled patients are to be initially examined by their primary care provider. If the patient has any urgent Dental Class 3 conditions, they will be appointed for this care; otherwise, they will be offered a dental hygiene appointment. After this appointment, the patient is scheduled to address any other Dental Class 3 conditions. Once these Dental Class 3 conditions are remedied, the patient can pursue the remaining dental treatment as per the critical pathway previously described. After one year from the last treatment date, the military patient is required to have another dental examination or they are placed in Dental Class 4. By definition, the DCRI model encourages offering a combined examination-hygiene appointment. Implicit in the model is the ability to provide at least one dental hygiene appointment per eligible beneficiary per year.

The DCRI advocates the use of a clinic central sterilization service and assignment of a treatment coordinator to every two teams. The Vilsek clinic currently has a central sterilization service but it is located in an inconvenient area in the clinic and its physical layout does not meet the recommended standards for a central sterilization service. Relocation of the central sterilization service closer to the open bays is being considered and this relocation was incorporated into the model layout. Additionally, the treatment coordinator was added to the model. This individual

schedules patients with their respective teams and handles some of the administrative functions relating to patient care needs. Patients report to the treatment coordinator once their dental appointment is finished for another appointment instead of the reception desk.

Evaluation of the centralized appointment book and the dental treatment logs coupled with the DCRI proposals indicated that the majority of the impaneled patients treated by the hygienist could be differentiated into the following categories: (a) scheduled adult dental hygiene patients, (b) scheduled adult examination-dental hygiene patients, and (c) scheduled periodontal (scaling and root planing) patients. The number of scheduled periodontal patients constitutes a minority of patients in the workload and, at the most, constituted two to three patients a week.

Considering the information obtained during the first visit and the DCRI critical pathway, flow diagrams were constructed to help determine patient flow under the DCRI concept and identify key areas in the patient flow to capture data (see Appendix C for Patient Flow Charts).

Data collection

The second phase consisted of data collection. Patient sign-in rosters at the reception desk were used to determine when the patients signed in for their appointments and compared to the respective time of their appointment in the centralized appointment book. This gave an indication of the variance in both the number and times of early and late patient arrivals. The Vilsek clinic policy is to schedule patients ten minutes prior to their actual appointment time which provides the dental team an opportunity to begin the appointment early. This policy was incorporated into the clinic modeling. The data extracted from the sign-in rosters and the centralized appointment book was processed using the Stat::Fit program option of the MedModel™ Healthcare Simulation software and the resultant distribution was incorporated in the model.

Some of the tasks inherent in civilian practice hygiene models are either delegated to other ancillaries in the ADCS or simply not done. For instance, in contrast to civilian dental practices, military patients scheduled to have a dental examination must have radiographs ordered by the dentist before they are exposed and developed. The military dental radiology service is centralized and usually a full-time technician is assigned there. A dental hygienist or dental assistant would not routinely be expected to expose and develop radiographs. Since the radiology service is centralized, the waiting time in the radiology queue in a large military dental clinic can be excessive and decrement from valuable clinic treatment time if radiographs are needed. Consequently, it is unrealistic to routinely secure dental radiographs during the adult examination-hygiene appointment. This factor was addressed in formulation of model. Additionally, the ADCS has not embraced the use of the intraoral video camera as a diagnostic or marketing tool.

Given these differences in the ADCS and private practice models, a detailed list of specific patient care tasks was outlined for scheduled adult dental hygiene patients, scheduled adult examination-dental hygiene patients, and scheduled periodontal (scaling and root planing) patients. The Europe primary care-DCRI model and the expanded hygiene models were analyzed and variations of each respective model were considered. Sequential task groupings were identified and these task groupings were delegated to either the dentist, the hygienist, or the dental hygiene assistant. Some task groupings could either be performed by the hygienist or the hygiene assistant. Considering this analysis, the following task sets required time motion studies:

Adult dental hygiene patient

1. Seat patient, review of medical history and oral hygiene, take the blood pressure if necessary, perform any administrative duties as required, and establish rapport with the patient (primary, hygiene assistant; secondary, hygienist).

2. Scale the teeth and reinforce oral hygiene (hygienist).

3. Polish and floss the teeth, reinforce oral hygiene, administer topical fluoride if necessary, and dismiss the patient [primary, hygienist; secondary, hygiene assistant (requires additional training)].

4. Clean and set up the dental operatory and deliver dirty instruments and handpieces to central sterilization (primary, hygiene assistant; secondary, hygienist).

5. Dental record entries (either the hygienist or the hygiene assistant).

Periodontal Patient

1. Seat patient, review of medical history and oral hygiene, take the blood pressure if necessary, perform any administrative duties as required, establish rapport with the patient, and notify the dentist that the patient is seated (primary, hygiene assistant; secondary, hygienist).

2. Administer local anesthesia [(wait inclusive of the time required to achieve the desired effects of the anesthesia (dentist)].

3. Scale the teeth, reinforce oral hygiene, and dismiss the patient (hygienist).

4. Clean and set up the dental operatory and deliver dirty instruments and handpieces to central sterilization (primary, hygiene assistant; secondary, hygienist).

5. Dental record entries (either the hygienist or the hygiene assistant).

Adult examination-dental hygiene patient

1. Seat patient, review of medical history and oral hygiene, take the blood pressure if necessary, perform any administrative duties as required, establish rapport with the patient, and notify the dentist that the patient is seated (primary, hygiene assistant; secondary, hygienist).

2. Examine the patient (dentist).

3. Scale the teeth and reinforce oral hygiene (hygienist).

4. Polish and floss the teeth, reinforce oral hygiene, administer topical fluoride if necessary, and dismiss the patient [primary, hygienist; secondary, hygiene assistant (requires additional training)].
5. Clean and set up the dental operatory and deliver dirty instruments and handpieces to central sterilization (primary, hygiene assistant; secondary, hygienist).
6. Dental record entries (either the hygienist or the hygiene assistant).

The data collected from these time motion studies was processed using the Stat::Fit program in the MedModel™ Healthcare Simulation software. This produced treatment time distributions that were incorporated into the creation of the models.

Model creation

The detailed analysis of both the Europe primary care-DCRI and the expanded hygiene models plus an evaluation of tasks that could be performed only by the hygienist and those that could be delegated to a hygiene assistant lead to the development of seven models. One model served as the control. Two of the models were associated with the Europe primary care-DCRI staffing concept and three were based on the expanded dental hygiene staffing concept. The seventh model incorporated the periodontal patient.

Control

Model 1: This model consists of only two hygienists--each working out of one dental chair. This model is currently used in most ADCS clinics.

Proposed Europe primary care-DCRI models for dental hygiene

Model 2: This model consists of two hygienists and one shared hygiene assistant working out of two dental chairs. The shared hygiene assistant is responsible for seating the patient, reviewing the medical history, taking the blood pressure if necessary, reviewing oral hygiene instructions, performing administrative duties associated with patient care, and establishing rapport

with the patient. The hygienist is responsible for the scaling, coronal polishing and flossing of the teeth, administering topical fluoride if necessary, reinforcing oral hygiene instructions, and dismissing the patient. The hygiene assistant is responsible for both the cleaning and setting up of the dental operatory and delivering dirty instruments and handpieces to central sterilization. Either the hygienist or hygiene assistant can place entries in the dental record.

Model 3: The only difference in this model from model 2 is that the hygienist can perform any of the tasks delegated to the hygiene assistant if the hygiene assistant is busy. The hygiene assistant does not perform any additional tasks.

Expanded hygiene models

Model 4: In this model, one hygienist and one hygiene assistant work out of two chairs. The hygiene assistant is responsible for seating the patient, reviewing the medical history, taking the blood pressure if necessary, reviewing oral hygiene instructions, performing administrative duties associated with patient care, and establishing rapport with the patient. The hygienist is responsible for the scaling, coronal polishing, and flossing of the teeth; administering topical fluoride if necessary; reinforcing oral hygiene instructions; and dismissing the patient. The hygiene assistant is responsible for both the cleaning and setting up of the dental operatory and delivering dirty instruments and handpieces to central sterilization. Either the hygienist or hygiene assistant can place entries in the dental record.

Model 5: The only difference between this model and model 4 is that the hygienist is allowed to do hygiene assistant tasks if the hygiene assistant is busy.

Model 6: Like model 5, the hygienist is allowed to accomplish hygiene assistant tasks if the hygiene assistant is busy. However, the hygiene assistant is allowed to assume the patient treatment duties of coronal polishing and flossing of the teeth, administering topical fluoride if

necessary, reinforcing oral hygiene instructions, and dismissing the patient if another patient is waiting for the hygienist to accomplish the scaling portion of their therapy.

Model 7: The seventh model examined the preferred time to schedule the periodontal patient for scaling and root planing procedures with emphasis on maximizing patient throughput.

The first six models were constructed and provisions were made to measure the throughput of patients and the percent utilization rates of the hygienists and hygiene assistants. The models also underwent four additional tests where feasible. The first measured their capacity to absorb a challenge of additional patients and would indicate if the current or proposed appointment templates were reasonable. The second test was designed to incorporate the dental examination-hygiene appointment into the model. In this scenario, the dentist examines the patient before the hygienist does the scaling component of therapy. This model will be useful approximately one year after the DCRI is introduced and can evaluate what if any adjustments in the appointment templates are required. A reasonable estimate is that one year after DCRI is implemented one third of the patients will require the examination-hygiene appointment. Likewise, approximately two thirds of patients presenting for hygiene appointments in the second year after the DCRI is introduced will require the hygiene-examination appointment; this was the model created and evaluated. At the end of this third year, most of the service members and their family members will depart from Europe for a new assignment. The third test is a challenge of additional patients to the hygiene-examination model to determine if the model is working at peak efficiency.

The fourth test to the six models and their variations is associated with a time limitation that hygienists usually invoke during the appointment. If the patient's hygiene condition requires more work than can reasonably be accomplished during the allocated appointment period or excessive bleeding occurs secondarily to inflammation of the patient's periodontium, the patient is

rescheduled and the appointment terminated approximately 50 minutes into the hygienist's time with the patient. These patients are rescheduled to return for completion of their cleaning versus trying to complete the appointment. This variable was incorporated into the models to measure the effect on patient throughput.

Model verification and validation

The third stage of the simulation approach was to create the model based on data collected either by time-motion studies or obtained from written documents archived in the clinic. The model was then shown to and verified by two ADCS board-certified comprehensive dentists familiar with clinic management to insure that it accurately depicted clinic operations. Considering this input, some data elements were revised and incorporated into the model.

Validation of the model involved comparing it to a real dental clinic system to determine whether the model was accurate. The data used to create the DCRI model came from either time motion studies conducted during actual clinic operations or administrative records. A base or control model was created and the treatment times and throughputs were compared to actual clinic data. The treatment time generated by the base model and patient throughput was recorded and this data favorably compared to data from actual clinic operations. The Europe primary care-DCRI and the expanded hygiene models were created for proposed reengineering initiatives and could not be directly compared to a clinic currently in operation. Two ADCS board-certified comprehensive dentists and one civilian registered dental hygienist that had experience with an expanded hygiene model in civilian practice established face validity of these models.

Each model was replicated 250 times (the equivalent of 50 weeks) to simulate one full-time year of clinical practice. The time of the cycle was adjusted to 9.34 hours [8 hours and 20 minutes for clinical practice and 1 hour (1130-1230) for lunch)]. The addition of twenty minutes to the

model run time is reasonable since patients signed in at the reception desk earlier than 0730 and 1230 hours (usually at or around 0720 hours and 1220 hours, respectively, due to the Vilsek clinic policy).

Appointment templates were formulated by challenging the models with an excess number of patients. Based on the patient challenge to the model, the optimum the number of patients and the respective length of the appointments were determined based on a four hour and ten minute block of time. The appointment template allotments that produced the optimum results were the one hour time frames for the control and the Europe primary care-DCRI models and one hour and ten minutes for the expanded hygiene models. These parameters were then programmed into each respective model.

CHAPTER 3

RESULTS

The control model, the two Europe primary care-DCRI models, and the three expanded hygiene models plus each respective model variation were simulated and the results are listed in Tables 1-8. These tables list the descriptive statistics of the patient throughput and the percent utilization rates of the dental hygienists and the hygiene assistant as appropriate for each model.

The hygienists each treat eight patients per day in the control model for a maximum of 16 patients treated per day. Contrary to what might be expected, the Europe primary care-DCRI models do not increase the total number of patients the hygienists are able to treat in the adult dental hygiene model (Tables 1 and 2). The adult dental hygiene and the adult examination-dental hygiene models were challenged with additional patients (Tables 3 and 4) without any significant change in patient throughput indicating that the proposed appointment templates used in the modeling are reasonable. (Patient throughput would have to increase to 18 and 14 for the Europe primary care-DCRI and expanded hygiene models, respectively, before any appointment template changes would be warranted.) When compared to the control model as shown in Table 1, there is some decrement of patient throughput in the adult dental hygiene model if the hygienist does not participate in the tasks that are usually reserved for the hygiene assistant (model 2). However, if the hygienist participates in the tasks that are normally performed by the hygiene assistant (model 3), it is reasonable that a patient can receive both their examination and hygiene appointment in the one-hour templates (Table 2).

Modeling the appointment templates indicates that it is reasonable for 12 patients to be treated per day by the expanded hygiene team of a hygienist and a hygiene assistant working out of two chairs (Table 1). If the hygiene assistant performs the polishing and flossing of the teeth when

the hygienist has another patient waiting for the scaling component of their therapy, the team is able to continue to comfortably provide the examination and hygiene appointment to 12 patients per day (Table 2).

It is not unusual for the hygienist to curtail the appointment length if the clinical therapy exceeds 45-50 minutes. All the models were challenged with a 50-minute time constraint to measure the effect on patient throughput as shown in Tables 5 and 6. There was not an appreciable change in patient throughput. The time-constrained models were then challenged with additional patients as shown in Tables 7 and 8. The patient challenge had a negligible effect on patient throughput. It was not feasible to model the time constraint for model 6 since both the hygienist and hygiene assistant could possibly participate in the clinical procedure. However, the results should be similar to those in model 5.

The percent utilization rates for the hygienist in the control model and the expanded duty hygienists are comparable. The percent utilization rates of the hygienists operating under the Europe primary care-DCRI model are significantly lower than their control and expanded hygiene counterparts.

Additionally, the periodontal patient was modeled in the expanded hygiene appointment template. Based of the treatment distribution times, the patient was allotted a one and one-half hour appointment and programmed to enter the model at different times in the appointment template. The arrival time for the periodontal patient that had the least effect on patient throughput was as the second patient in the four hour and ten minute appointment time blocks.

Table 1

Descriptive Statistics of the Adult Dental Hygiene Appointment

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	15.9	.3	90.8	4.8	91.3	4.7		
Europe Primary Care-DCRI [a]								
2	15.1	.8	62.2	4.3	61.8	4.0	55.5	3.8
3	15.9	.7	70.7	6.8	71.4	6.0	33.0	2.8
Expanded Hygiene [b]								
4	11.7	.5	89.7	4.4			47.3	3.0
5	11.7	.5	91.4	4.4			44.9	3.6
6	12.0	.2	83.1	4.5			57.1	4.3

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

Table 2

Descriptive Statistics of the Adult Examination-Dental Hygiene Appointment

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	15.1	.8	95.6	3.6	96.3	2.5		
Europe Primary Care-DCRI [a]								
2	14.8	.8	61.7	4.4	60.8	4.4	60.0	3.0
3	15.9	.5	74.3	6.3	77.7	5.5	37.7	3.4
Expanded Hygiene [b]								
4	11.6	.5	88.5	4.3			57.6	3.2
5	11.4	.6	93.2	3.6			52.4	3.7
6	12.0	.2	87.0	4.5			63.6	4.2

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

Table 3

Descriptive Statistics of the Adult Dental Hygiene Appointment Challenged With Additional Patients

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	16.5	.8	98.0	2.2	94.8	3.0		
Europe Primary Care-DCRI [a]								
2	15.5	1.0	66.0	4.1	62.8	3.7	57.2	3.6
3	17.3	1.7	79.2	6.4	77.5	8.3	35.6	4.6
Expanded Hygiene [b]								
4	12.4	.9	95.3	3.4			51.8	4.1
5	12.4	.8	97.4	1.5			49.3	3.8
6	13.4	.6	93.0	3.7			65.3	4.4

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

Table 4

Descriptive Statistics of the Adult Examination-Dental Hygiene Appointment Challenged With Additional Patients

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	15.3	.8	98.9	.5	97.2	2.0		
Europe Primary Care-DCRI [a]								
2	15.3	.9	65.1	4.1	61.5	3.9	62.1	3.3
3	16.8	.9	83.2	4.3	82.8	4.8	40.0	3.5
Expanded Hygiene [b]								
4	12.2	.7	94.3	2.0			63.2	3.7
5	11.8	.8	97.6	1.4			57.0	4.1
6	13.6	.6	95.9	2.5			69.9	4.7

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

Table 5

Descriptive Statistics of the Adult Dental Hygiene Curtailed Appointment

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	15.9	.2	90.2	4.7	90.8	4.2		
Europe Primary Care-DCRI [a]								
2	15.2	.8	61.4	4.1	61.4	4.2	55.6	3.4
3	15.9	.8	70.2	5.9	71.2	6.3	32.9	2.9
Expanded Hygiene [b]								
4	11.8	.4	88.4	4.5			47.6	3.5
5	11.8	.4	90.6	4.4			44.7	2.9

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

Table 6

Descriptive Statistics of the Adult Examination-Dental Hygiene Curtailed Appointment

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	15.4	.6	95.5	3.6	96.4	2.4		
Europe Primary Care-DCRI [a]								
2	14.9	.8	60.8	3.9	60.2	4.2	60.1	2.9
3	15.9	.6	74.0	6.1	78.0	5.9	37.8	3.7
Expanded Hygiene [b]								
4	11.8	.4	87.9	4.1			57.9	2.7
5	11.5	.6	92.8	3.6			52.5	3.4

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

Table 7

Descriptive Statistics of the Adult Dental Hygiene Curtailed Appointment Challenged With Additional Patients

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	16.7	.6	97.8	2.3	94.4	2.9		
Europe Primary Care-DCRI [a]								
2	15.5	1.1	65.4	4.6	61.3	4.6	57.8	4.0
3	17.5	1.1	78.1	5.8	77.8	5.9	35.8	3.4
Expanded Hygiene [b]								
4	12.6	.8	95.5	2.4			52.7	3.8
5	12.5	.8	97.1	1.8			49.5	3.5

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

Table 8

Descriptive Statistics of the Adult Examination-Dental Hygiene Curtailed Appointment Challenged With Additional Patients

	Patient Throughput		% Utilization Rates					
			Hygienist 1		Hygienist 2		Hygiene Assistant	
Model	M	SD	M	SD	M	SD	M	SD
Control								
1	15.4	.7	98.9	.7	97.3	1.7		
Europe Primary Care-DCRI [a]								
2	15.1	.8	63.6	3.8	60.2	3.7	61.7	3.6
3	16.9	1.3	82.8	4.2	82.8	6.3	39.7	4.6
Expanded Hygiene [b]								
4	12.4	.7	94.1	2.2			64.1	3.6
5	11.8	.8	97.5	1.4			57.8	4.1

[a] Appointments were templated for one hour.

[b] Appointments were templated for one hour and ten minutes

CHAPTER 4

DISCUSSION

The DCRI is scheduled to begin testing in the spring of 1998 with the expectation that it will eventually "seed" to other dental clinics in Europe. Computer simulation has indicated that it is reasonable for a hygienist to treat eight patients per day if they continue to function out of one chair with or without an assistant. The addition of a shared hygiene assistant to two primary care teams configured under the Europe primary care-DCRI staffing model for the adult dental hygiene appointments would be an unwise management decision. A review of the utilization rates indicates that there is a trade-off of utilization from the hygienist to the hygiene assistant with little to no gain in patient throughput. The Europe primary care-DCRI model would be appropriate for the combined examination-dental hygiene appointments that should populate the appointment templates one-year post-DCRI implementation.

The expanded hygiene model is an alternative to the Europe primary care-DCRI model considering the hygienist shortage in Europe. Instead of one hygienist per primary care team, a hygienist and a hygiene assistant would be assigned to two primary care teams and function out of two dental chairs. This staffing/dental chair ratio accommodates the variation in dental hygiene appointment lengths and results in a total of 12 patients treated per day by the hygienist-dedicated hygiene assistant team. The utilization rates indicate for the hygienist functioning under the expanded hygiene model are comparable to those of the hygienists in the control model. This should alleviate the hygienist's concern that they will be expected to work harder under the expanded hygiene model.

Table 9 demonstrates a comparison of the total number of patients that can be seen per year if the Europe primary care-DCRI model and the expanded hygiene model are implemented.

One hygienist functioning under either model can adequately address the hygiene needs of the 1,400 patients impaneled to each primary care team. The expanded hygiene model offers a potential of 2880 hygiene appointments that can address the dental hygiene needs of two primary care panels. The unknown factors potentially increasing demand will be the number of patients in the two panels who require scaling and root planing for their periodontal condition and the number of patients who require an additional hygiene appointment to consummate their hygiene needs. There will be a number of patients, especially family members, who do not pursue dental hygiene appointments and may offset the additional demand.

The shortage of hygienists in Europe has the potential to derail the full implementation of DCRI if each primary care team requires a dental hygienist. The hygienist shortage is acute in some military communities as evidenced by one community that does not have any dental hygienists on their staff (Roger Worthington, personal communications, January 28, 1998). It is doubtful that the 26 additional hygienists required to fully implement DCRI can be recruited and hired given the current monetary and personnel constraints in Europe.

The expanded hygiene model requires fewer total hygienists than the Europe primary care-DCRI model if the DCRI is implemented throughout the ERDC. Current estimates indicate that 107 hygienists will be required to fully implement the Europe primary care-DCRI model. There are currently 81 hygienists in the European theater for a deficit of 26 hygienists. If the expanded duty hygiene model is implemented, a total of 54 hygienists will be required to staff the primary care teams. It is reasonable to convert at least the 26 unfilled hygienist slots to hygiene assistant slots. As the DCRI is seeded to other clinics in Europe, the total number of hygienists could be further reduced to a number between 81 and 54. The hygiene slots would then be converted to hygiene assistant slots resulting in a potential cost savings.

The computer simulation model was constructed so every programmed arrival presented to the clinic. The failure rate of hygiene appointments in the military varies but can approach an average of 20-30 percent as evidenced from data gathered by the practice manager at the Fort Hood DCRI "beta" test site (Tony Rogers, personal communications, March 19, 1998). The treatment coordinator becomes an important member of the primary care dental team to insure that the hygiene service is scheduled appropriately. The ability to monitor appointment schedules, maintain short call rosters, and confirm appointments when feasible should increase the productivity of the hygiene service. During the collection of data for this project, it was noted that very little effort was made by reception or clinic personnel in Europe to confirm appointments or fill failed appointments.

Considering "what if" analysis and the ability to stress the models by either increasing the number of individuals presenting for treatment or varying the length of the appointment, the appointment template as shown in Table 10 would be reasonable for the expanded hygiene model. Additionally, the one and one half-hour appointment template offered for periodontal patients was reasonable. Based on the treatment distribution times, the periodontal patient was programmed to enter the model at different times in the appointment template. Computer simulation suggests that the scheduling for the periodontal patient that has the least effect on patient throughput is as the second patient in either the morning or afternoon. The patient is placed in the second chair early and the anesthesia is given. This allows the anesthetic to take effect and the patient is ready for the procedure once the hygienist treats their first patient.

Table 9

Comparison of the Total Numbers of Hygiene Appointments Per Year Offered by the Proposed Hygiene Models

Staffing Ratio per 2 Teams	Total Numbers Hygiene Appointments
2 Hygienists	2 Hygienists*8patients/day*48 weeks*5 days/week = 3840 total hygiene appointments/2 hygienists or 1920 hygiene appointments/hygienist
1 Hygienist/1 Hygiene Assistant	12 patients/day*48 weeks*5 days/week 2880 hygiene appointments / hygienist

Table 10

Proposed Appointment Template for Expanded Hygiene Model

Hygiene Chair	
1	2
0730	0750
0830	0900
0940	1010
1220	1250
1330	1400
1440	1510

Table 11

Proposed Expanded Hygiene Model Incorporating a Periodontal Patient

1	2
0730	0740 (Periodontal Patient)
0900	0940
1010	
or	
1220	1240 (Periodontal Patient)
1400	1440
1510	

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This study was designed to evaluate two different hygiene-staffing mixes under the six-chair constraint of the Europe primary care-DCRI model. The two-hygienist/two chair/one shared hygiene assistant ratio as advocated by the Europe primary care-DCRI staffing model does not demonstrate increased clinical efficiencies. The one hygienist/two chair/one dedicated hygiene assistant staffing mix as defined by the expanded hygiene model is a viable alternative staffing configuration, especially given the dental hygienist shortage in Europe. An analysis of the panel sizes and the number of dental hygiene appointments offered by the expanded hygiene team indicates that it has the potential to provide the dental hygiene needs of two panels of patients. Additionally, the expanded hygiene model offers the ability to offer an examination and a cleaning during the same appointment without degradation in patient throughput. It should be considered as the preferred hygiene-staffing model for U.S. Army dental clinics in Europe.

One recommendation to further research in hygiene appointment scheduling would be to conduct a time distribution study to determine whether a patient's Periodontal Screening and Recording Score (PSR) score affects the length of the hygiene appointment. The PSR is a screening tool that is used to rapidly assess the patient's periodontal status during the dental examination. The PSR is recorded in codes from 0 to 4--the smaller the code number, the less intervention is required. It is possible that the appointment time can be customized by the PSR code findings. Computer simulation could then be used to further refine the appointment templates.

Appendix A

Definitions

Definitions

Dental Class 1—dental classification indicating that a dental patient does not require dental treatment or reevaluation in 12 months.

Dental Class 2—dental classification indicating that a dental patient may have oral conditions that, if not treated or followed up, have the potential but are not expected to result in a dental emergency within 12 months.

Dental Class 3—dental classification indicating that a dental patient may have oral conditions that, if not treated or followed up, will likely result in a dental emergency within 12 months.

Dental Class 4—dental classification indicating that a patient requires an either an annual or other required examinations. Dental Class 4 is reserved is also reserved for patients whose classification is unknown.

(Bennett, 1996)

Appendix B

Disc Inventory of Models

Disc Information

Disc 1

Models 1 & 2

Disc 2

Models 3 & 4

Disc 3

Models 5, 6, & 7

Variations of Models ("#" refers to the model number)

1. mod # : This model version has no special modifications.

2. mod# -50: This model version has programming in the processing section of the build menu that curtails the amount of time the hygienist spends scaling, polishing, and flossing the teeth; reinforcing oral hygiene; administering topical fluoride; and dismissing the patient to a maximum of 50 minutes.

3. mod# -max: This model version has programming in the arrival section of the build menu that increases the number of hygiene patients presenting to the dental clinic.

4. mod# -50max: This model version has programming in both the arrival and processing section of the build menu that curtails the amount of time the hygienist spends scaling, polishing, and flossing the teeth; reinforcing oral hygiene; administering topical fluoride; and dismissing the patient to a maximum of 50 minutes and increases the number of hygiene patients presenting to the dental clinic.

5. mod# -exam: Two out of every three hygiene patients who report to the dental clinic in this model version require a dental examination that is provided during the hygiene appointment.

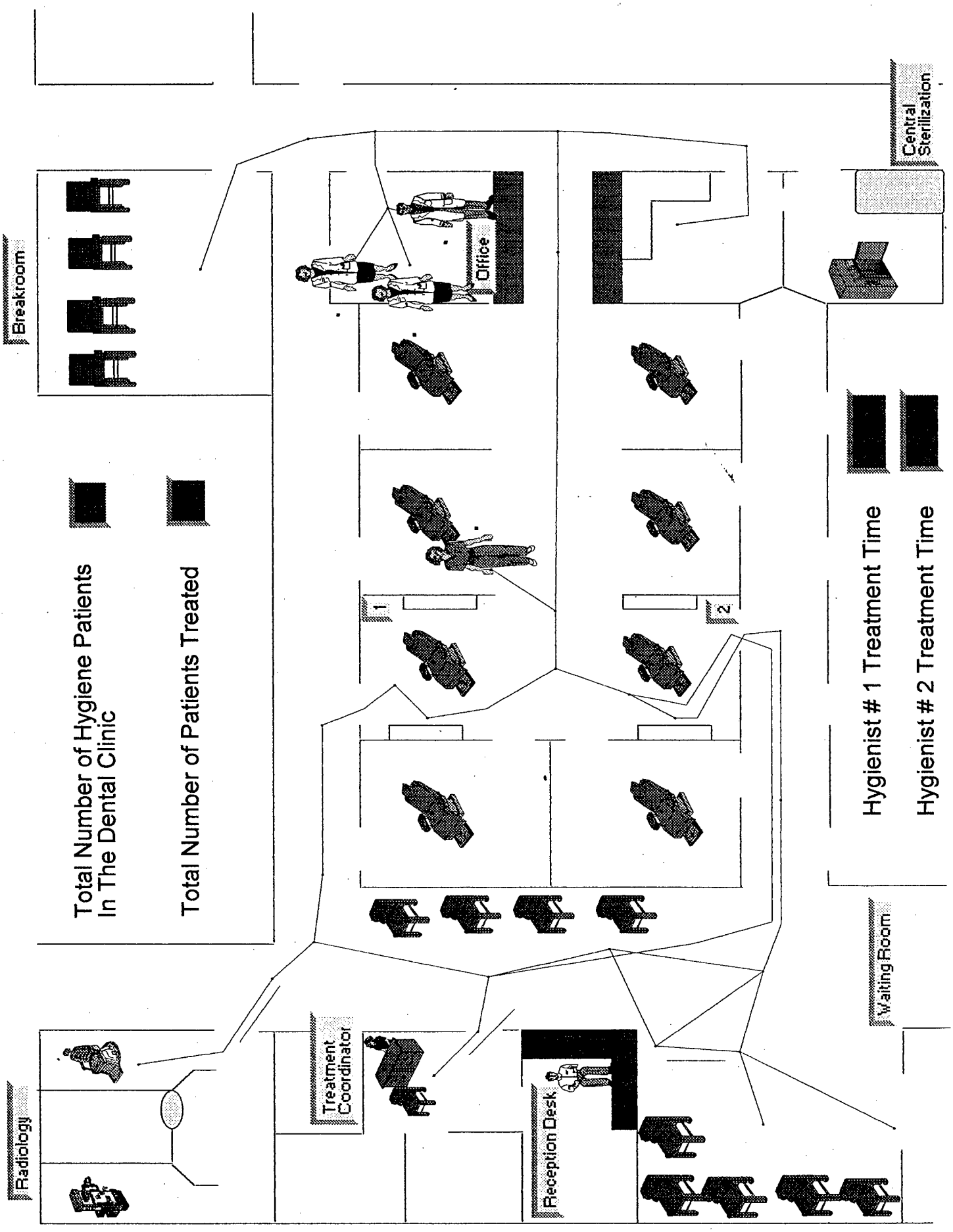
6. mod# -exam50: In this model, two out of every three hygiene patients who report to the dental clinic in this model require a dental examination which are provided during the hygiene appointment and there is programming in the processing section of the build menu that curtails the amount of time the hygienist spends scaling, polishing, and flossing the teeth; reinforcing oral hygiene; administering topical fluoride; and dismissing the patient to a maximum of 50 minutes.

7. mod# -exammax: Two out of every three hygiene patients who report to the dental clinic in this model version require a dental examination that is provided during the hygiene appointment. Additionally, the arrival section of the build menu has programming to increase the number of hygiene patients presenting to the dental clinic.

8. mod# -exam50max: Two out of every three hygiene patients who report to the dental clinic in this model version require a dental examination that is provided during the hygiene appointment. The arrival section of the build menu has programming to increase the number of hygiene patients presenting to the dental clinic. Additionally, there is programming in the processing section of the build menu that curtails the amount of time the hygienist spends scaling, polishing, and flossing the teeth; reinforcing oral hygiene; administering topical fluoride; and dismissing the patient to a maximum of 50 minutes.

Appendix C

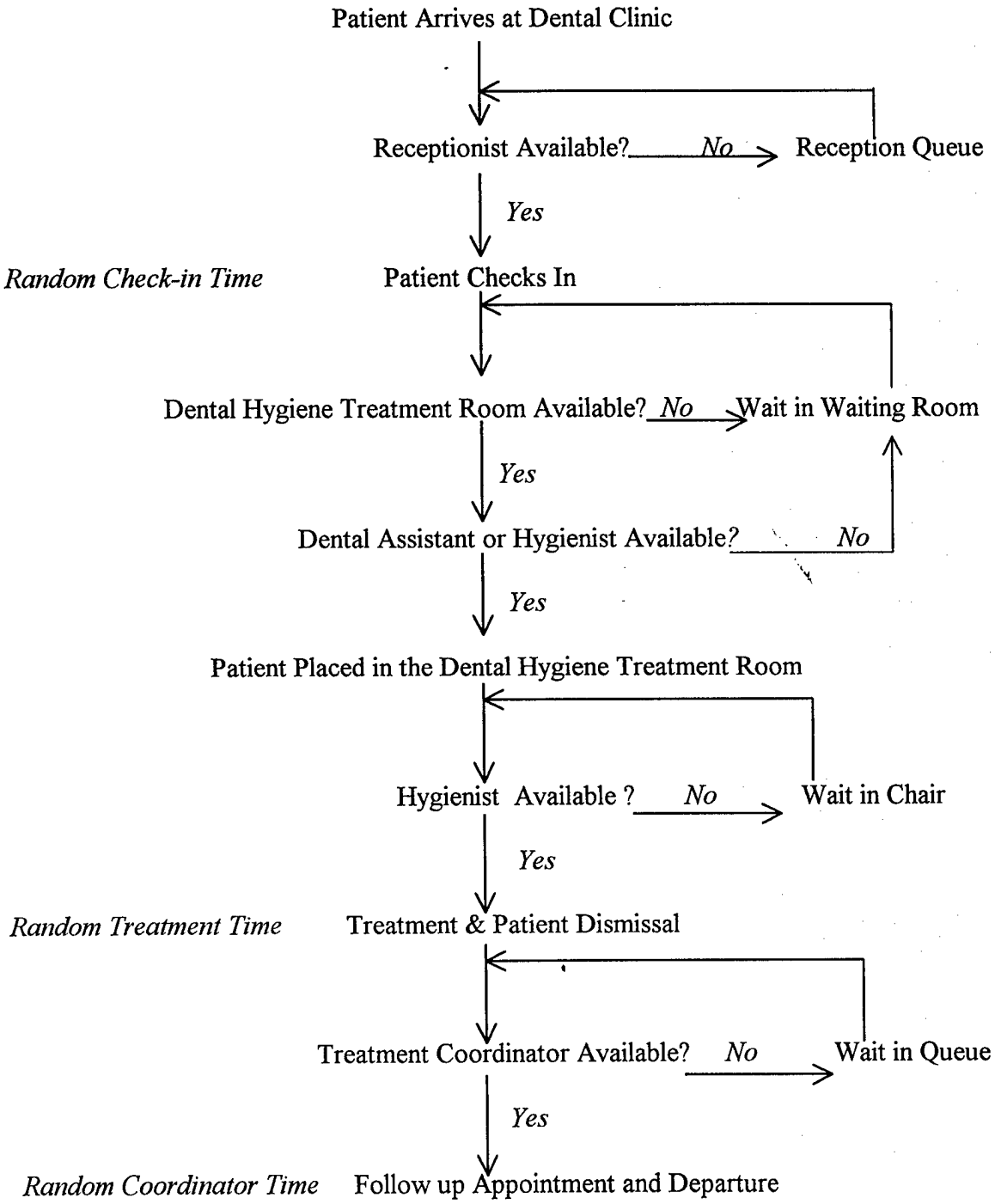
MedModel™ Graphic: Clinic Layout


Breakroom
Total Number of Hygiene Patients In The Dental Clinic
Total Number of Patients Treated
Office
Central Sterilization
1
2
Hygienist # 1 Treatment Time
Hygienist # 2 Treatment Time
Radiology
Treatment Coordinator
Reception Desk
Waiting Room

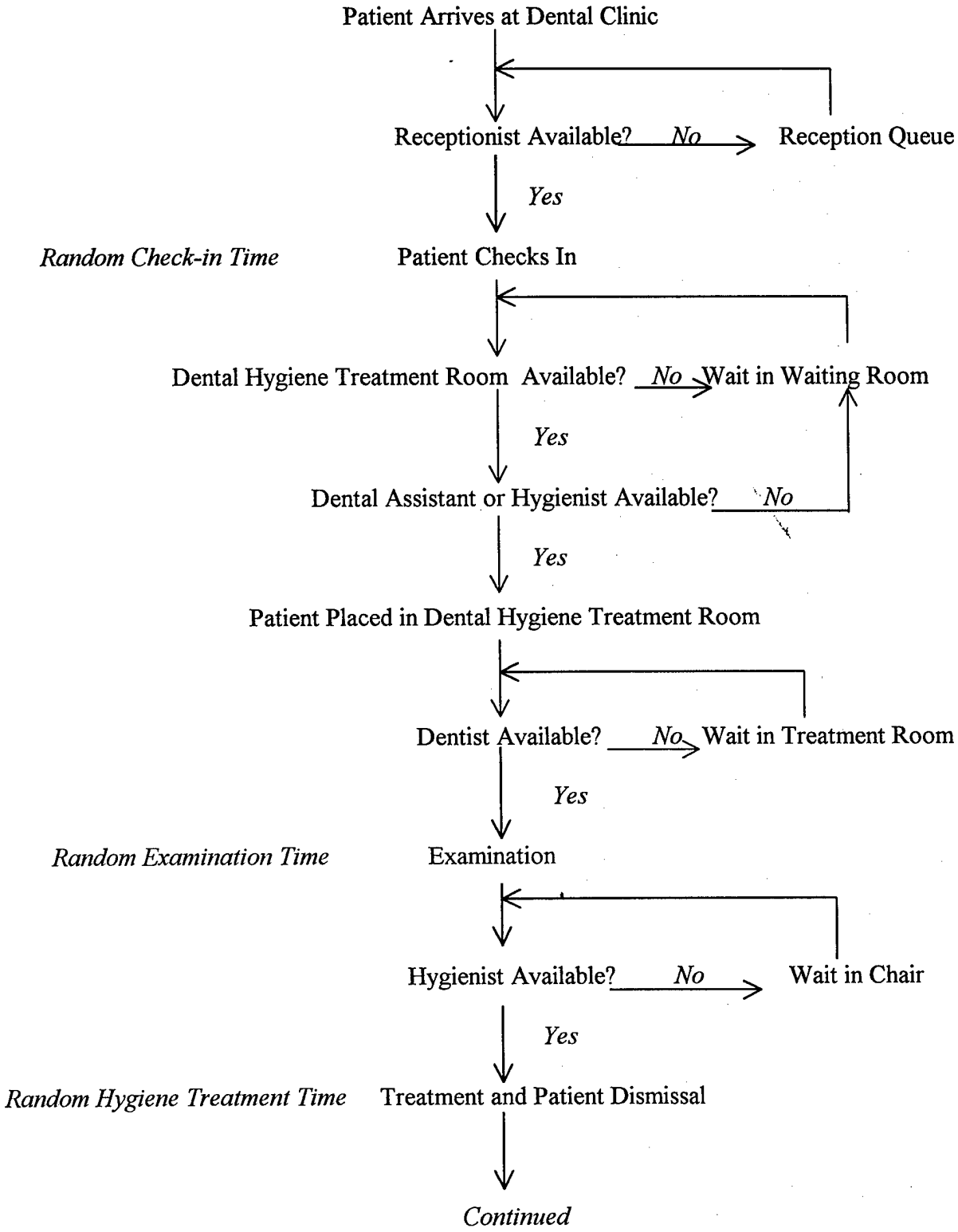
Appendix D

Patient Flow Diagrams

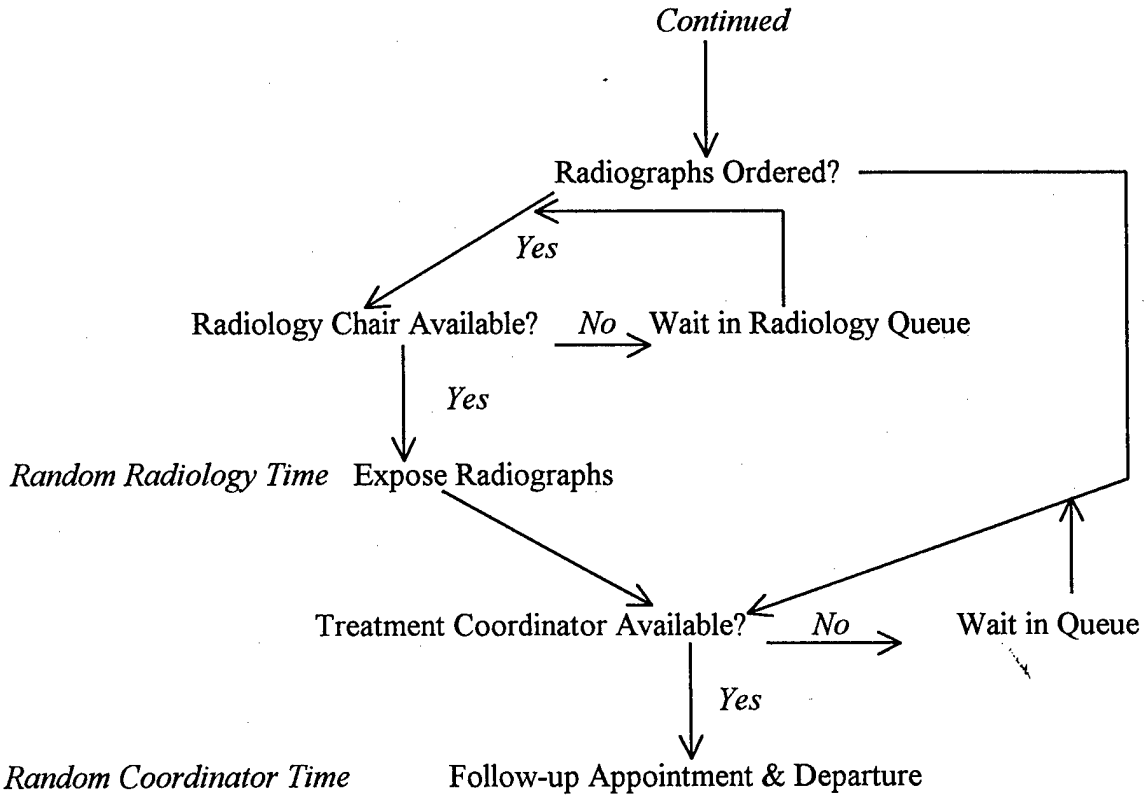
Dental Patient Flow Under the DCRI: Scheduled Dental Hygiene Patient



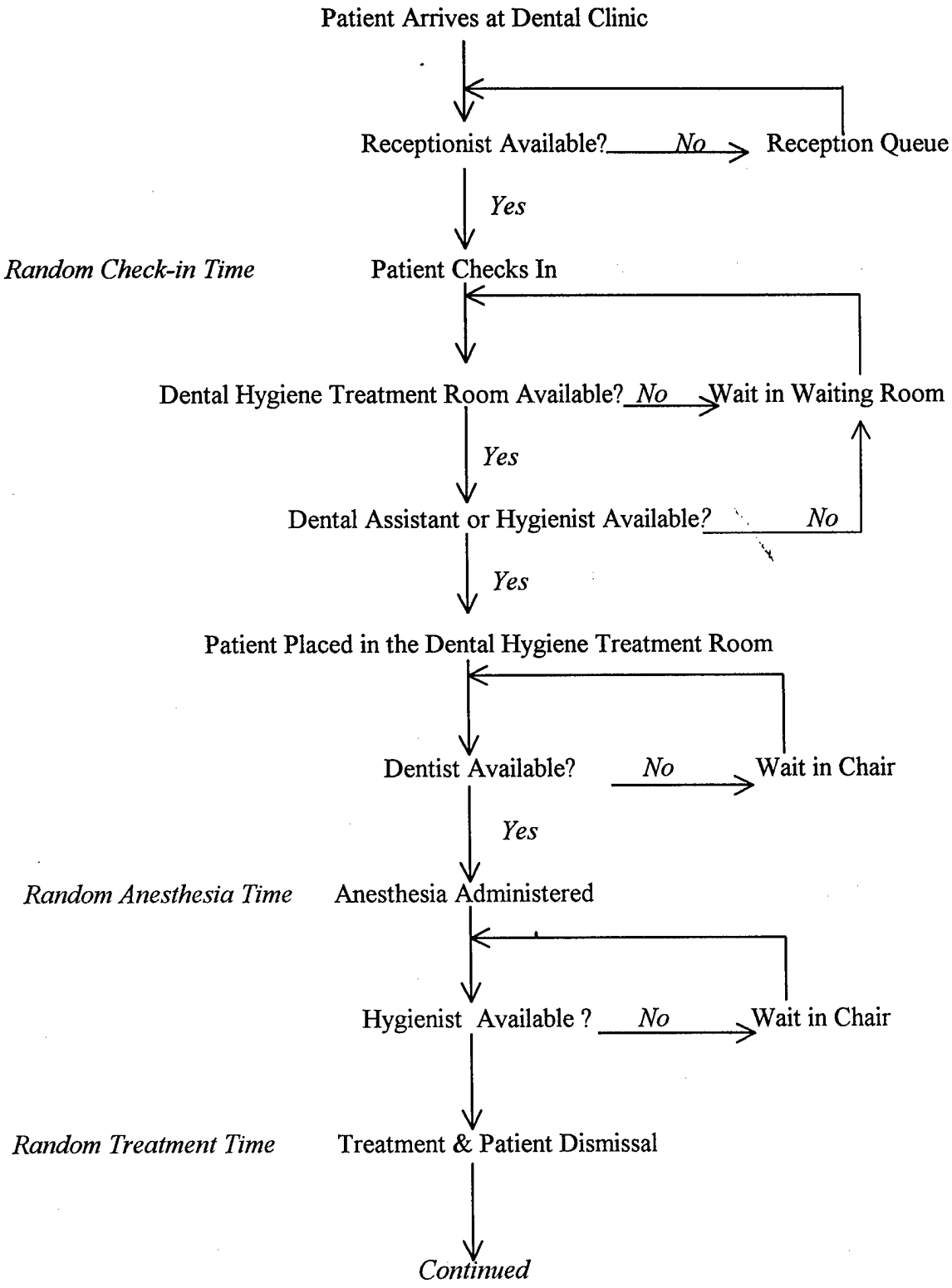
Patient Flow Under the DCRI: Scheduled Examination-Hygiene Patient



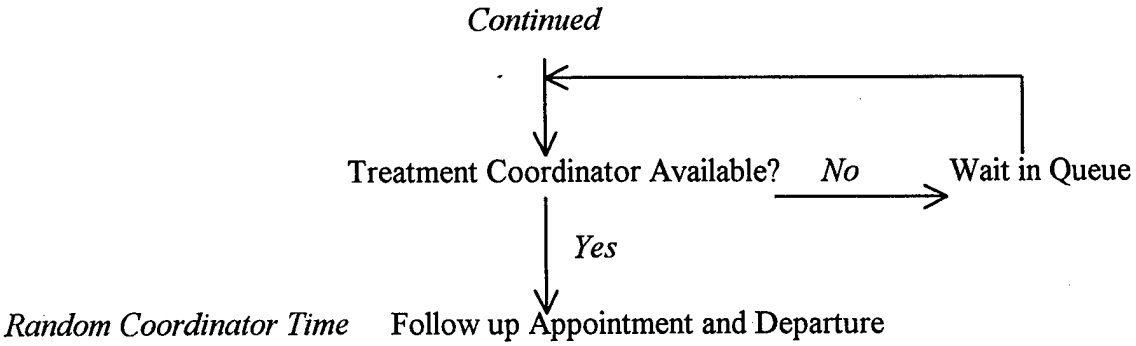
Patient Flow Under the DCRI: Scheduled Examination-Hygiene Patient



Dental Patient Flow Under the DCRI: Scheduled Scaling and Root Planing Patient



Dental Patient Flow Under the DCRI: Scheduled Scaling and Root Planing Patient



Appendix E

Time Motion Study Data

Time Motion Study Data for the Adult Hygiene Patient

The information of the following two pages is time motion study data for the adult hygiene patient. Each column is labeled with a letter. Each respective letter translates into a specific task groupings as explained below. The best fitted distribution type for the treatment times and the formula as prescribed by the Stat::Fit Program follows.

A: Time required to seat patient, review of medical history and oral hygiene, take the blood pressure if necessary, perform any administrative duties as required, and establish rapport with the patient. Pearson 6 (1, 1, 4.88, 2.67); 1+P6(4.88, 2.67, 1)

B: Scale the teeth and reinforce oral hygiene (hygienist). Weibull (7, 2.09, 20); 7+W(2.09, 20)

C: Polish and floss the teeth, reinforce oral hygiene, administer topical fluoride if necessary, and dismiss the patient. Loglogistic (1, 4.35, 10); 1+10*(1./((1./U(0.5,0.5))-1.))**(1./4.35)

D: Columns (B + C). Erlang (18, 4, 4.54); 18+ER(18.2, 4.54)

E: Clean and set up the dental operatory and deliver dirty instruments and handpieces to central sterilization. Weibull (2.78, 7.39); 3+W(2.78, 7.39)

F: Total amount of time required to treat the patient. Columns (A+B+C+E)

Time Motion Study Data For Adult Hygiene Patients

Patient	A	B	C	D	E	F
1	3.0	23.5	17.5	41.0	16.5	60.5
2	3.0	16.0	9.0	25.0	10.0	38.0
3	2.0	22.5	10.0	32.5	10.0	44.5
4	4.5	27.5	11.0	38.5	8.0	51.0
5	13.5	13.0	12.0	25.0	9.5	48.0
6	4.0	22.0	13.5	35.5	9.0	48.5
7	3.5	28.5	6.5	35.0	13.0	51.5
8	1.5	13.5	15.0	28.5	15.0	45.0
9	2.5	22.0	13.0	35.0	11.0	48.5
10	2.5	7.5	11.0	18.5	8.5	29.5
11	3.0	23.5	23.0	46.5	10.5	60.0
12	3.0	16.0	9.0	25.0	10.0	38.0
13	2.0	22.5	10.0	32.5	10.0	44.5
14	1.5	14.5	9.5	24.0	7.0	49.5
15	1.5	24.5	8.0	32.5	8.0	42.0
16	1.5	15.5	10.5	26.0	8.0	35.5
17	2.0	20.5	11.0	31.5	7.0	40.5
18	4.0	9.0	24.0	33.0	9.0	46.0
19	2.5	20.5	12.5	33.0	13.0	48.5
20	4.0	22.5	10.0	32.5	8.5	45.0
21	8.5	17.5	11.5	29.0	6.5	44.0
22	3.5	16.0	12.5	28.5	6.5	38.5
23	2.0	30.0	10.5	40.5	6.5	49.0
24	5.0	23.0	10.5	33.5	9.0	47.5
25	8.5	20.0	12.5	32.5	5.0	46.0
26	2.0	18.0	10.0	28.0	12.0	42.0
27	1.5	22.0	11.5	33.5	6.0	41.0
28	2.5	22.0	10.5	32.5	13.5	48.5
29	2.5	14.0	25.0	39.0	4.5	46.0
30	4.0	26.5	10.0	36.5	8.0	48.5

Time Motion Study Data For Adult Hygiene Patients

Patient	A	B	C	D	E	F
31	9.5	23.0	8.0	31.0	6.5	47.0
32	1.0	14.5	11.0	25.5	3.0	29.5
33	1.5	18.0	15.0	33.0	11.5	46.0
34	2.8	28.0	1.0	29.0	12.0	43.8
35	3.0	23.0	6.5	29.5	8.5	41.0
36	1.5	38.5	4.0	42.5	10.0	54.0
37	6.5	21.0	12.5	33.5	11.0	51.0
38	2.0	25.0	16.0	41.0	10.5	53.5
39	8.5	36.0	3.5	39.5	11.0	59.0
40	7.0	32.5	8.5	41.0	5.0	53.0
41	3.0	18.0	8.0	26.0	11.0	40.0
42	11.0	26.0	4.0	30.0	10.5	51.5
43	2.0	20.0	12.0	32.0	9.0	43.0
44	3.0	44.0	8.5	52.5	8.0	63.5
45	4.0	27.5	12.5	40.0	10.0	54.0
46	3.0	35.5	10.5	46.0	9.5	58.5
47	6.0	37.5	13.0	50.5	11.5	68.0
48	3.0	46.5	8.0	54.5	13.5	71.0
49	3.5	28.0	11.0	39.0	6.5	49.0
50	10.0	30.0	19.0	49.0	6.5	65.5
51	5.0	20.0	13.5	33.5	11.0	49.5
52	3.5	21.0	10.0	31.0	14.0	48.5
53	3.5	31.5	15.0	46.5	12.5	62.5
54	3.5	32.0	15.0	47.0	10.5	61.0
55	2.5	26.0	13.5	39.5	8.0	50.0
56	2.5	47.0	2.5	49.5	9.0	61.0
57	2.0	32.0	12.0	44.0	12.5	58.5
58	2.5	33.5	11.0	44.5	6.0	53.0
59	2.0	41.0	13.5	54.5	11.5	68.0
60	3.0	38.5	11.5	50.0	9.0	62.0

Time Motion Study Data For Periodontal Patients

The information of the following page is time motion study data for the periodontal patient. Each column is labeled with a letter. Each respective letter translates into a specific task groupings as explained below. The best fitted distribution type for the treatment times and the formula as prescribed by the Stat::Fit Program follows.

A: Time required to seat patient, review of medical history and oral hygiene, take the blood pressure if necessary, perform any administrative duties as required, establish rapport with the patient, deliver local anesthesia inclusive of the wait to achieve its effects.

Pearson 5(3, 4.46, 45.8); 3+P5(4.46, 45.8)

B: Scale and floss the teeth followed by dismissing the patient. Pearson 6(23, 55.9, 4.31, 13.3); 23+P6(4.31, 13.3, 55.9)

C: Clean and set up the dental operatory and deliver dirty instruments and handpieces to central sterilization. Beta (2, 21, 1.6, 1.18); B(1.6, 1.18, 2, 21)

D: Total amount of time required to treat the patient. Columns (A+B+C)

Data for Periodontal Patients

Patient	A	B	C	D
1	20.0	55.0	11.0	86.0
2	30.0	43.0	16.0	89.0
3	14.0	40.0	20.0	74.0
4	15.0	47.0	8.0	70.0
5	25.0	49.0	4.0	78.0
6	10.0	35.0	17.0	62.0
7	23.0	40.0	15.0	78.0
8	10.0	54.0	21.0	85.0
9	13.0	38.0	14.0	65.0
10	7.0	33.0	11.0	51.0
11	15.0	47.0	16.0	78.0
12	15.0	65.0	17.0	97.0
13	11.0	29.0	15.0	55.0
14	12.0	43.0	20.0	75.0
15	10.0	65.0	20.0	95.0
16	25.0	54.0	16.0	95.0
17	16.0	42.0	10.0	68.0
18	10.0	75.0	5.0	90.0
19	22.0	51.0	2.0	75.0
20	15.0	40.0	8.0	63.0
21	3.0	26.0	11.0	40.0
22	3.0	54.0	5.0	62.0

Time Motion Study Data for Dental Examinations, Radiology, and Record Entries

The best fitted distribution type for the treatment times and the formula as prescribed by the Stat::Fit Program follows:

Examination Time: Exponential (3, 2.93); 3+E(2.93)

Radiology Time: Lognormal (1, 0.98, 0.533); 1+L(3.07, 1.76)

Record Entries: Erlang (1, 1, 1.31); 1+ER(1.31, 1.31)

Time Motion Study Data For Examinations, Radiology, and Record Entries

Exam time	Radiology	Record Entries
7.5	2.0	1.0
7.0	2.5	1.0
5.5	4.0	2.0
5.0	3.0	1.0
4.0	3.0	1.0
3.5	2.5	2.0
3.0	3.0	2.0
3.0	2.0	1.0
5.5	2.0	1.0
7.5	5.0	1.0
11.0	1.0	3.0
3.5	2.0	4.0
7.0	5.0	2.0
11.0	3.0	6.0
5.0	4.5	2.0
5.0	6.5	2.0
3.0	4.0	3.0
5.5	4.0	3.0
8.5	3.5	4.0
8.0	4.0	2.5
4.0	4.5	2.5
11.0	6.5	2.5
5.0	3.5	4.0
4.0	4.0	2.5
8.0	8.0	2.0
6.0	5.0	3.5
6.0	2.5	3.5
5.0	3.5	2.0
4.0	6.0	2.0
	4.0	4.0
	4.0	2.0
	6.5	2.0
	3.5	1.0
	2.5	1.5
	7.5	2.0
	3.0	1.5
	4.0	
	3.0	
	7.0	

Data Indicating Sign-in Times on Clinic Rosters for Dental Hygiene Patients

The "0" is 10 minutes before the appointment which is the time on the patient appointment slip. The -25 is the number of minutes before the 10 minutes sign in time; the "10" is 10 minutes after the appointed time. Fitted distribution type and formula as prescribed by Stat::Fit: Weibull (-25, 2.8, 24.7); Formula used : -25+W(2.8, 24.7)

-25	-15	-5	-5	0
-25	-15	-5	0	0
-25	-10	-5	0	0
-20	-10	-5	0	0
-20	-10	-5	0	0
-20	-10	-5	0	0
-20	-10	-5	0	0
-20	-10	-5	0	5
-20	-10	-5	0	5
-20	-10	-5	0	5
-20	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-10	-5	0	5
-15	-5	-5	0	5
-15	-5	-5	0	5
-15	-5	-5	0	5
-15	-5	-5	0	5
-15	-5	-5	0	10
-15	-5	-5	0	10

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